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Mulching Planted Ponderosa Pine Seedlings In Arizona Gives Mixed Results

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Mulching of 3-0 spring-planted ponderosa pine seedlings on difficult sites with clear and black polyethylene, petraleum-emulsion, volcanic cinders, waadchips, and dead grass sod was generally ineffective. Nane of the mulches significantly improved survival, but in a few instances polyethylene increased height growth. Black polyethylene was the only effective mulching material that persisted thraugh the study; the ather mulches deteriarated rapidly or were easily disturbed, and became ineffective.

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Guidelines for artificial reforestation in the Southwest (Schubert et al. 1969, 1970) make little mention of mulching materials and techniques because of lack of research. Various attributes of mulches — retention of soil moisture, possible increase in soil temperature, and protection of seedlings from competition — along with successful experiences elsewhere (DeByle 1969, Fraser 1968, Loewenstein and Pitkin 1970, Takatori et al. 1963) prompted experimentation with mulching materials to improve planting success on difficult sites.

We found, however, that a one-time application of mulches at the time of planting gives mixed results. Many problems were encountered, several of them unexpected, which resulted in either the mulch being destroyed or rendered ineffective.

Study Areas and Methods

The study consisted of two plantations of 3-0 ponderosa pine (Pinus ponderosa Laws.) established on mechanically prepared sites (except for herbicide plots at A-1 Mountain) — one on watershed 12 (clearcut) of the Beaver Creek Project in 1967, and one on the A-1 Mountain burn, near Flagstaff, in 1968. Both locations were difficult planting sites, with site index around 55 (Minor 1964) and stony clay loam soils. At each location, the experimental plot consisted of four replications of six mulch treatments: (1) petroleum mulch,[2] a water emulsion of petroleum resins sprayed on the ground, (2) black polyethylene, (3) clear polyethylene, (4) volcanic cinders, (5) woodchips (watershed 12 only), (6) herbicide-killed grass (A-1 Mountain only), and (7) no mulch. Each mulched spot was 18 inches square. The polyethylene squares were slit in the center to fit over the seedlings, and were weighted down with rocks; cinder and woodchip mulches were 2 inches deep; the dead grass mulch was achieved by spraying live grass cover with dalapon and planting seedlings in the dead sod.

Soil temperature and moisture at 2- to 4-inch and 10- to 12-inch depths under the mulches were measured with thermocouples and moisture resistance blocks, respectively. Data were

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[2] *ENCAP Agricultural Mulch was supplied by the ESSO Research and Engineering Company. Trade names and company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

also taken on seedling survival, height growth, and time of root-growth initiation (some seedlings were excavated) and bud burst.

Results and Discussion

The first-year results at watershed 12 were disappointing (table 1). Neither survival nor total heights of mulched seedlings were significantly different from the controls. At A-1 Mountain, on the other hand, most mulches slightly decreased survival, but improved height growth of surviving seedlings (table 1). Only "dead grass" significantly decreased survival; the grass was not completely killed, and competed for moisture. Other studies at nearby locations have shown that, with complete grass kill, survival may be as high as 99 percent after 1 year (Heidmann, unpublished data). All of the treatments, except the dead grass, significantly increased first-year height growth of surviving trees at A-1 Mountain. The polyethylene-mulched seedlings grew most.

The results were slightly different at the time the study was terminated in 1970 (table 1). Overall survival dropped considerably, but the first-year trends persisted. Survival was highest on the control plots, but only the dead grass treatment was significantly lower. Seedlings mulched with black polyethylene at watershed 12 and both polyethylenes at A-1 Mountain were significantly taller.

The mulches had no detectable effect on time of initiation of root growth or bud burst.

During the first growing season, soil moisture was significantly higher under the polyethylene and cinder mulches, while soil temperature was reduced under the cinder and woodchip mulches at the 2- to 4-inch depth only. None of the mulches had any consistent influence on soil moisture or soil temperature in the root zone (10 to 12 inches), although variation was high. Apparently, height growth of the seedlings was favored by the combination of higher soil moisture and warmer soil temperature under the polyethylene mulches, but not by higher soil moisture with cooler soil temperature under cinders.

Interfering factors contributed to the lack of response to mulching. Mulches were often destroyed or rendered ineffective. Many of these factors were unsuspected at the beginning of the experiment. The petroleum mulch rapidly deteriorated from the action of weathering processes—especially freezing and thawing, solar radiation, and soil microorganisms—and finally disappeared from the impact of large raindrops and hailstones. It did not remain long enough to exert much influence. The woodchip mulch also washed away quickly. The clear polyethylene mulch acted as a greenhouse for weeds which developed vigorously beneath it and bulged the mulch up from the ground. Moreover, the mulch disintegrated from solar radiation by late summer of the first growing season. The black polyethylene mulch did not suffer these problems. Overall, the black poly-

Table 1.--Survival and height of planted ponderosa pine seedlings, by mulch treatment, at end of first year and at end of study

Mulch	Watershed 12 (planted 1967)				A-1 Mountain (planted 1968)			
	Survival		Height		Survival		Height	
	1968	1970	1968	1970	1969	1970	1969	1970
	Percent		*cm*		*Percent*		*cm*	
Petroleum	65	31.3	7.0	24.9	71.0	53.8	10.8*	15.2
Black polyethylene	61	37.5	7.3	25.8**	78.3	56.3	12.3*	19.0*
Clear polyethylene	65	42.5	7.3	25.4	63.8	51.3	12.6*	18.6*
Cinders	64.5	40.0	5.5	22.8	92.0	53.8	9.8**	12.8
Wood chips	69	26.3	6.1	24.5	--	--	--	--
Dead grass	--	--	--	--	53.3*	32.5**	6.9	11.4
Control	63	35.8	6.7	23.9	80.0	62.5	8.0	13.0

* Significant at 0.01 level.
** Significant at 0.05 level.

ethylene and cinder mulches were most persistent.

A larger mulched area would most likely produce an increment of improved survival and growth, but would still be subject to the interfering factors discussed above.

Although the effect of the mulches on survival in this study was disappointing, mainly because the mulches broke down, a study conducted in the same area in 1960 showed that a mulch of three rocks significantly improved survival (Heidmann 1963). The rocks tend to stay in place, and thus continue to provide beneficial effects. Dead grass sod can effectively conserve soil moisture (Heidmann 1969), but the grass cover should be uniformly heavy and killed completely by the herbicide.

Conclusions

It was not possible to assess the benefit of these mulches over a several-year period since the mulches deteriorated and the benefits were lost. Therefore, the results at the conclusion of the study in 1970 are not as meaningful as those after 1 growing season. Replacing disturbed mulches is not practical. Mulches which stay in place, such as rocks or other relatively unmovable material, are to be preferred.

On the basis of this study, the value of mulches as an aid to survival and growth of ponderosa pine seedlings in the Southwest remains uncertain. Even though some of the mulches improved height growth significantly, survival was still unacceptable. On difficult planting sites, satisfactory results can be achieved by using complete site preparation, planting vigorous trees carefully, and giving them initial protection from competition, wildfire, and livestock.

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